

Thesis/
Reports
Radtke, K.

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LOW-FUEL PLANT RESEARCH AGREEMENT

Radtke, K.
FINAL PROGRESS REPORT

July 1, 1975 - September 30, 1976

U.S. Forest Service
and
Los Angeles County Fire Department
Cooperative Agreement 21-235

Presented by Research Forester
Klaus Radtke

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Many people have supported this low-fuel plant research project over the years. Foremost was our dedicated friend and Range Scientist Dr. Eamor Nord, who was a constant inspiration to Los Angeles County and especially to me for more than seven years. His death truly has left a void in our midst.

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Klaus Radtke

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ABSTRACT

The close cooperation between the Los Angeles County Fire Department's Forestry Division and the U.S.F.S. Riverside Fire Laboratory was strengthened in March 1973, by the initial cooperative research agreement on low-growing and/or slow-burning plants. This agreement has yielded excellent plants for wildland use and greenbelt plantings around homes in brush areas. The plants have also shown applications other than their prime purpose of providing low fuel. Some are excellent for erosion control, wildlife habitat, grazing, mine spoil rehabilitation, sand dune stabilization, aesthetics, etc. The complete benefit of studies done through this project can therefore best be realized if these plants are utilized to their fullest potential.

The shortcoming of the research project was its inability to create mass plantings of economically feasible fuelbreaks. Fuelbreak plantings have been expensive and difficult and may not succeed unless other management objectives such as grazing are included and/or weedy species are controlled through the intelligent use of chemicals.

Mass plantings of low-fuel plants for brush conversion are not recommended for Southern California's wildlands. However, the selective use of the proper plants in chaparral management is highly recommended. This requires the expertise of personnel who have spent much time in the field and are familiar with these plants. A computerized system of plant material information is then needed to make this data readily available to the land manager.

INTRODUCTION

This final progress report describes the low-fuel plant research carried out during the last 18 months by the Los Angeles County Fire Department, Forestry Division, under the Cooperative Forest Service Agreement 21-235. It also summarizes the findings of this agreement and discusses work done in its support by both agencies prior to 1974.

Table 1 - Cooperative Research Agreement 21-235 (7101)

March 15 - June 30, 1973:

Six test sites (no maintenance) were established through the outplanting of 7,096 low-fuel plants in 12" tar liners. Three existing demonstration sites were expanded with 1,605 plants, and two new demonstration sites were established using 1,455 plants. Creeping sage (Salvia sonomensis) was evaluated through the bare root planting of 2,232 plants on fourteen different sites ranging in elevation from 1,500' to 5,500'.

July 1, 1973 - June 30, 1974:

Worldwide low-fuel plant research was initiated through travel and correspondence. More than 200 plant species were recommended of which 50 species were received. Twenty of these were evaluated for a wide variety of uses.

The project's major fertilizer test plot was established in East Topanga, using nine plant species. Growth measurements were taken every season during the first year. Bare root plantings and pregerminated seed trials were carried out in Malibu and the evaluation of previous outplantings was continued.

July 1, 1974 - June 30, 1975:

Attempts were made to establish five acres of fuelbreaks through outplanting of more than 14,200 plants, primarily Creeping sage. Creeping sage strain tests were started with the outplanting of eight strains of Creeping sage collected from throughout California. The pamphlet "Low-Fuel Plant Research for California" was published to bridge the language gap for overseas collaborators. Previous outplantings were evaluated and summarized.

July 1, 1975 - June 30, 1976:

More than three acres of two previously initiated seed accession plots were made fully operational through the establishment of more than 2,000 plants consisting of more than 20 indigenous and introduced species. Introduction, growing, outplanting, and evaluation of indigenous and introduced plant species was continued.

Proposed outplantings and subsequent evaluation of preemergent chemicals were canceled due to the extreme drought season. Creeping sage potted stock received from the Riverside Fire Laboratory was outplanted on four sites in the Angeles National Forest.

July 1, 1976 - September 30, 1976:

Steps were taken to phase out the low-fuel plant program at the Riverside Fire Laboratory. Seed accession, the introduction and testing of introduced species, and the evaluation of previously established plants was continued.

FINAL PROJECT EVALUATION

Interagency Cooperation

Prior to his death, Dr. Eamor Nord finished his summary of ten years research aimed at finding and developing low-growing, low-volume, and/or slow-burning vegetation. Along with Lisle Green's contribution on grasses, it will now be published by the Forest Service, PSW Station in Berkeley under the title, "Low-Volume and Slow-Burning Vegetation for Planting on Clearings in California Brushlands."

Our Forestry Division is pleased that it was able to contribute to this booklet through this cooperative agreement and earlier personal cooperation between the authors and its own personnel. A great admiration for the dedication of deceased Range Scientist Dr. Nord and a mutual respect among the cooperating scientists further enhanced the viability of the program.

Nord and Green's publication is a compilation of practical knowledge on the subject of slow-burning vegetation up to 1974, and also discusses the problems encountered in field establishment of low-fuel plants. The reader is therefore referred to it. Additional discussions in this report emphasize research since 1974 and the overall evaluation of the project. The three year-end progress reports written to date give basic information regarding the research and also discussed its shortcomings, successes, and long-term direction.

The Los Angeles County Forestry Division supported the Riverside Fire Laboratory's program on plant exploration, plant propagation, outplantings, and evaluation of low-fuel plants. The Fire Laboratory's present incorporation of the program as part of chaparral ecology research is viewed as an excellent management move in that it enables more direct contact and cooperation among agencies and individuals. It also makes it more readily possible to find practical applications for the wide range of chaparral research done so far, including low-fuel plant research.

Fire Resistant Plants

A quick look at the history of the project shows that prior to the Riverside Fire Laboratory's involvement, low-fuel plant research was already well established as "FIRE-RESISTANT PLANT RESEARCH." Many people actually believed

that "fire-resistant plants" existed. They planted them around their homes only to find out that these plants burned quite readily. In the 1950's and early 1960's, more emphasis was placed on "fire-retardant plants". Nevertheless, many people in the brush areas still found it hard to understand why "fire-retardant plants" like Cistus spp. and rosemary burned so readily.

In 1965 Dr. Eamor Nord gave the project a new direction by deemphasizing "fire-retardance" and emphasizing "low-growing, low-fuel, and/or slow-burning plants". It was pointed out that ash content and ultimately fuel moisture determine the flammability of plants. So, the search went out for plants with a high ash and moisture content and minimal fuel buildup over the years. Saltbushes (Atriplex spp.) were natural candidates. However, through field plantings it was discovered that even saltbushes, unless properly managed, burn readily as they become old and woody even though they do not burn as hot or as readily as most chaparral species. For example, Old Man's Saltbush (Atriplex nummularia) is recommended in Australian literature as fire-retardant and is grazed to reduce fuel buildup. In the Middle East it is planted for firewood. With additional irrigation, a two-year old plantation yielded 10,000 kg of firewood/hectare (Franclet and LeHouerou, 1971).

Living "Fire-Safe" in the Chaparral

A misunderstanding so readily perpetuated by the shake and shingle companies, and also sidestepped by some agencies, is the fact that even a lawful minimum 100 feet brush clearance around a home will do little to save the home during a conflagration if it has a wood roof. This was well demonstrated in the 1973 Rolling Hills Fire in Los Angeles County. The Rolling Hills City Ordinance prescribed wooden shingle roofs to give the community a rustic appearance. Furthermore, many of the estate-like homes had a well established greenbelt of ivy, ice plants, and other landscape shrubs and trees and were therefore "fire-proofed" to the maximum of the law. Then in June 1973, a grass and mustard (Brassica spp.) fire erupted on the slopes below the community. Ascending fire brands ignited twenty-one roofs and destroyed eleven houses; yet in many instances, the greenbelts around the homes were not burned. After this fire, a city ordinance was adopted forbidding wooden shingle roofs on new homes.

A Stanford Research Report (Howard et al. 1973)

stated that 49% of wood roof homes located in the chaparral would catch fire during their lifetime. Furthermore, the National Fire Protection Association in its national survey (Tyron, 1962) found that during major conflagrations an average of 378 houses with wooden shingles were consumed compared to only 61 houses involving other types of roofs. The N.F.P.A. Handbook (McKinnon & Tower, 1976) also lists wood roofs as the principal factor contributing to conflagrations, even exceeding fire danger caused by winds in excess of 30 mph (data: 1901 - 1967).

The Los Angeles County Fire Department, charged with the protection of life and property in its watershed areas, supports the outlawing of wooden shingle roofs in Fire Zone 4 areas (chaparral areas). As a result of the disastrous 1970 wildfires, such an ordinance was in force in Los Angeles County from October 1970, to April 1971. However, the ordinance was eliminated through the pressure of special interest groups. Presently, the County Board of Supervisors is once more investigating the adoption of such an ordinance.

From the above discussions it may be seen that living relatively safe in the chaparral requires both a properly maintained greenbelt around the home and a "fire-proof" constructed house.

Establishment of Low-Fuel Plants

For many years plant succession in Southern California has been undergoing a rather marked change. The introduction of weedy grass species, woody species like mustard and castor bean (Ricinis communis), and the seeding of burns with ryegrass (Lolium spp.) has injected many foreign species into the succession cycle. These weedy species compete heavily with planted stock and seeding operations, especially on more marginal soils.

Because of this, Dr. Nord lost many planting sites, and the Forestry Division is fighting to retain its fuelbreak project along East Topanga. The Forestry Division lost relatively few plantings over the years because it had a readily available and well supervised work force of both inmates and fire control laborers which aided in weeding the converted areas.

Seeding or planting of wildland sites can therefore not be recommended unless:

1. A fallow and disking program is initiated to eliminate weedy species or resprouting chaparral.
2. Pre-emergent chemicals are selectively used to eliminate most competing weedy vegetation.
3. Grazing is utilized on a regular basis.

The low-fuel plant program was continually called upon to plant on marginal sites or on sites that had previously been disturbed and where the invasion of weedy species was evident. Non-selective pre-emergent herbicides have often proved useful for outplantings but could not be used for direct seeding. Chemicals were used very sparingly because many of the planting sites were on Forest Service, C.D.F., and private land, and restrictions on herbicide use were severe.

Strong competition for low-fuel plants is also apparent on burns the first few seasons after a fire. Fire releases nutrients into the soil facilitating growth of low-fuel plants but the reestablishment of well adapted fire-type species is so prolific that any planting or seeding is doomed to failure. Planting or seeding here is also not possible without a fallow period, use of selective herbicides, or grazing.

Utilization of chaparral appears to be the best hope for proper chaparral management and the control of wildfires. The poorer countries of the world have utilized their brush resources through grazing (overgrazing quite often) which provides a vitally needed meat product. Our rich and inventive country could add to this utilization by developing additional uses for chaparral such as fuel, medical, decorative, game ranching, recreational, and others.

Prescribed burning also plays an important role in chaparral management in that it more closely resembles nature's way of eliminating fuel buildup. Aesthetically pleasing supplemental plantings with low-fuel plant species of high nutrient content could favor a grazing program aimed at fuel reduction. Plants could also be used in high value areas such as around structures and on roadside fuelbreaks.

Computerized Low-Fuel Plant Data for Wildland Plantings

Table 2 lists some low-fuel plant species, all of which, except species #1 (Acacia ongerup), have been discussed in the report on "Low-Volume and Slow-Burning Vegetation . . ." (Nord and Green, 1976). The table shows that much information exists on low-fuel plants that could readily be summarized in a form adaptable for computer models to fit chaparral management needs.

The plants are graded from 1 to 4 with 0 denoting that the column is not applicable to this situation. Number 4 indicates the most positive correlation with the criteria column; number 1 the least. It can be seen that species 1 - AC ON (Acacia ongerup) has proven to be highly persistent (does not fade out), forms a dense cover (eliminating weeds once it is established), has shown itself to be virtually maintenance free for at least five years, and has a high visual impact in both summer and winter. Moreover, the table shows that the plant can only be grown from cuttings since seedling vigor is 0. Also, fuel buildup could be a problem because the plant is not palatable and grows to several feet tall on level sites (implied with fuel buildup). Such tables could also include information on pH, preferred soil types, cold and drought tolerance, growth rates, ease of establishment, and preferred habitat.

Table 2 also points out that there are few plants available that would persist as large communities (groundcover mass plantings). The preferred habit of most plants was found to be small colonies or multispecies mixtures.

Table 2 Performance of low-fuel plants under wildland conditions
in Los Angeles County (2,000' elevation and 20" rainfall)

Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Criteria	
Name	AC ON	AR CA	AT MU	AT RH	BA PI	CI CR	CI LA	CI VI	GA PU	MY PA	RO OF	SA CH	SA VI	SA SO		
	4	2	3	4	3	3	4	4	4	2	4	4	4	1-2	PERSISTENCE (after 4 years)	
	0	0	2	2	0	1	2	2	4	0	0	0	0	1(4)	1/	SEEDLING abundance
	0	0	3	3	0	2	3	3	4	0	0	0	0	4		vigor
	4	4	1	2	4	2	2	2	4	3	2	2	2	2	HABIT	forms communities
	1	3	3	3	2	3	3	3	1	2	3	3	3	2		forms colonies
	4	4	3	3-4	4	3	2	2-3	4	3	3	3	3	2	CROWN DENSITY (cover formed)	
	3	1	2-3	3	3	3	4	3-4	3	2	3-4	2	2	2	MAINTENANCE (free for at least 5 years)	
	1	4	1	3	4	1	1	1	1	4	3	1	1	4	STEM LAYERING/RESPROUTING	
	1	4	3	2-3	1	1	1	1	3	3	1	2	2	3	NON-FLAMMABLE (low-fuel)	
∞	2	4	3	1-2	2	2	1	2-3	2-3	4	3	2	2	4	2/	MIN. FUEL BUILDUP (after 5 years)
	4	4	4	3-4	4	4	4	4	4	4	4	4	4	4		VISUAL - winter/spring
	3	2	3	2-3	3	1-2	2-3	2-3	2-3	2	3	3	2-3	1-2		IMPACT - summer/fall
	2	1	2	4	2	2	3	2	2	1	2	2	2	1		WILDLIFE - cover
	1	1	4	4	1	1	1	1	2	1	1	1	1	1	3/	VALUES - browse

1 Acacia ongerup
2 Artemisia caucasica
3 Atriplex muelleri
4 A. rhagioides
5 Baccharis pilularis

6 Cistus crispus
7 C. ladaniferus
8 C. villosus
9 Galenia pubescens
10 Myoporum parvifolium

11 Rosmarinus officinalis
12 Santolina chamaecypariss
13 Santolina virens
14 Salvia sonomensis

1/ (4) when scarified by fire

2/ 1 = 6-8 tons/acre
2 = 4-6 tons/acre
3 = 2-4 tons/acre
4 = less than 2 tons/acre

3/ Plants are graded from 1 to 4.
0 denotes that the criteria
column is not applicable to this
plant. 4 denotes the most positive
correlation, 1 the least.

LOW-FUEL PLANT PROJECT REPORT # 4
(July 1, 1975 - June 30, 1976)

Abstract

The 1975-76 growing season was extremely dry with less than half the normal rainfall received in many areas of Southern California. Dry site plantings of low-fuel plants and direct seeding efforts were therefore suspended in order not to waste valuable potted stock and seeds. More efforts were spend on seed accession and demonstration plots and on the further evaluation of introduced plant species.

After the death of Range Scientist Dr. Nord, plants stored at the Riverside facility were either out-planted or moved to the Forestry Division's Research Station in Malibu for outplanting during the 1976-77 growing season.

Plant Introductions

Even though evaluation of low-fuel plant species is continuing, the Forestry Division feels that the Cooperative Agreement has paid its way by making available many new plants for erosion control and landscape amelioration (Table 3 and 4, pages 12 to 15).

If one considers ease of establishment, vigor, and browse value, one of the most exciting of these new species is Atriplex glauca of North Africa. For erosion control the stem layering and quick-spreading Atriplex undulata from Australia is well adapted. Another good erosion control plant is Lycium spp. from Turkey. With irrigation, this plant formed runners in excess of ten feet within nine months. Prostrate Acacia ongerup has proved to be very drought resistant and spreads vigorously in coastal climates. Atriplex repanda is being considered in the Range profession for its high protein content and its adaptability for grazing. A. rhagioides has shown its value as wildlife forage in the Malibu Mountains. The vine-like Kennedia rubicunda is good for soil erosion and landscaping, and Polygonum equisetiforme is being considered for both grazing and sand dune stabilization in arid regions. Oenothera drummondii is a very attractive coastal dune stabilizer.

Because of their attractiveness, all five species listed in Table 4 for dry site landscaping will probably be available through the landscape trade within a few years. Russian sage (Artemisia caucasica) is already available in some nurseries in Los Angeles County. More species could have been included in Tables 3 and 4, but further evaluation is needed. A fact sheet about plant species introduced since 1973 is in progress and will be available to other agencies in the near future. Presently we are hard pressed in meeting the many requests for this kind of information and carrying out the many seed exchanges.

Seed Accession Efforts

The lack of large quantities of readily available seeds of low-fuel plant species has always been a drawback to the wider acceptance of certain promising plants and for the project itself. A two acre seed accession plot was therefore initiated by the Forestry Division two years ago. Located at the Wayside Honor Rancho Prison Farm in

Castaic, the plot offers readily available labor, water for irrigation, security, and a sandy soil with a slightly acid pH. The conversion of a seven-year old alfalfa field was finally accomplished after several diskings and fallow periods. The first half-acre planted to Galenia pubescens was destroyed the spring of 1976 because of suspected poisonous aspects of this species (see section on poisonous plants). Since then more than 2,000 plants of primarily saltbush species (indigenous and introduced) were established from both seeds and transplants. Initial seed crops of Atriplex coquimbana, A. glauca, A. hymenelytra, A. muelleri, A. malvana, A. repanda, A. rhagioides, and A. undulata are being harvested presently or will be harvested this fall and winter. These seeds and seeds of other species harvested from the Malibu and Riverside Fire Laboratory plots will be used this winter for direct seeding trials on the following Forestry Division projects:

1. Aqueduct wildlife habitat
2. Fuelbreak trials in the Newhall/Saugus area
3. Roadside stabilization and beautification
(through our Special Projects Section)
4. Cooperative Forest Service revegetation efforts
of the high sulfur soils along Highway 14

Admittedly, much work still has to be done on germination testing and seeding trials, but the tools are now available to do it on a larger scale. The Forestry Division's Special Projects Unit, specializing in roadside stabilization, is always in need of effective plant material and has done much in demonstrating the practical applications of low-fuel plants. The Research Unit, therefore, has a ready outlet to do this testing on a larger scale once it has produced the necessary plant materials.

Additional work in progress includes a fertilizer drip irrigation system for the two-acre Honor Rancho and half-acre Malibu seed accession plots. It is hoped that maximum yield will thus be achieved from a small area, both in amount of seed harvested and in higher seed fill and germination percentage. Weeds are presently being controlled with agricultural chemicals like Treflan and its new replacement Surflan. Continued weed control through soil fumigation for direct seeding trials and soil coverage with polyethylene sheeting are being considered.

Table 3 Additional shrubs for wildland settings to reduce fire hazard in Southern California
(fuelbreaks, road sites, etc.)

<u>Name</u>		<u>1/ Elevation (feet)</u>	<u>Establishment</u> Seed Transpl.		<u>Growth Rate</u> Fast Med. Slow		<u>1/ pH test plots</u>	<u>Height</u>	<u>Remarks</u>
Acacia ongerup	2/	0-2,000+		X	X		5.5 - 8.0	18"	Prostrate. Very competitive robust plant from Australia. May spread to 15 feet or more. Showy yellow flowers.
Atriplex coquimbana	2/	0-2,000+	X	X	X	X	6.0 - 8.0	3'	Upright browse plant from Chile.
Atriplex glauca	2/	0-2,000+	X	X	X		6.0 - 8.5	3'	Semi-prostrate. Vigorously re-sprouting browse plant from N. Africa. Needs grazing to remain robust.
Atriplex malvana		0-2,000+	X	X		X	6.0 - 8.5	3'	Semi-prostrate browse plant from N. Africa.
Atriplex repanda		0-3,000	X	X	X	X	6.5 - 8.0	4'	Upright. Excellent browse plant from Chile. Prefers coastal regions.
Atriplex rhagioides	2/	0-3,000	X	X	X		5.0 - 8.0	4'	Upright to semi-prostrate. Good browse plant from Australia for coastal regions. Needs browsing to remain vigorous.

Table 3 (continued)

<u>Name</u>	<u>1/ Elevation (feet)</u>	<u>Establishment</u>		<u>Growth Rate</u>		<u>1/ pH test plots</u>	<u>Height</u>	<u>Remarks</u>	
		Seed	Transpl.	Fast	Med.	Slow			
Atriplex undulata	0-3,000	X	X	X	X		5.0 - 8.0	3'	Semi-prostrate. Vigorously stem- layering plant from Australia. Good for erosion control. Spreads to 15' across.
Eriogonum wrightii spp. subcaposum	4,500- 9,000	X	X			X	4.5 - 6.5	2"	Ground cover under- story for conifers. Native to the An- geles National Forest. Seeds germinate readily.
Kennedia rubicunda	0-2,000+	X	X	X			5.5 - 8.0	1'	Prostrate to semi- upright. Vigor- ously spreading vine from Australia. Excellent for erosion control in coastal regions.
Polygonum equisitiforme	0-2,000+	X	X	X			5.5 - 7.5+	3'	Semi-prostrate to upright. Stem layers readily. Used for sand dune stabilization in Israel. Weedy but excellent possibilities for grazing, and erosion control.

Table 3 (continued)

<u>Name</u>	<u>1/ Elevation (feet)</u>	<u>Establishment</u> Seed Transpl.		<u>Growth Rate</u> Fast Med. Slow		<u>1/ pH test plots</u>	<u>Height</u>	<u>Remarks</u>
Oenothera drummondii	2,000	X	X	X		5.5 - 8.5+	3'	Semi-prostrate from Israel. Has showy yellow flowers. Excellent for erosion con- trol in coastal areas. Builds up fuel volume.
Lycium spp.	0-4,000	X	X	X	X	6.5 - 8.0+	4'	Semi-prostrate to upright from Turkey. With irrigation, the plant forms run- ners exceeding ten feet in length.

1/ Preliminary data

2/ Available through Pecoff Bros. Nursery, Escondido, CA

Table 4 Additional shrubs for dry site landscaping (need supplemental irrigation).

<u>Name</u>	<u>1/ Elevation (feet)</u>	<u>Establishment</u>		<u>Growth Rate</u>			<u>1/ pH our test plots</u>	<u>Height</u>	<u>Remarks</u>
		Seed	Transpl.	Fast	Med.	Slow			
Artemisia caucasica	0-6,000+		X		X	X	5.5 - 8.0	4"	Very attractive silver-blue ground cover -- needs mowing after seeds set.
Hardenburgia violacea	0-2,000+	X	X	X			5.5 - 7.0+	to 4'	Very attractive blue flowers.
15 Hertia cheirifolia	0-2,000+	X	X		X		5.5 - 8.0	to 1'	Very attractive yellow flowers, leathery leaves; Exc. for coastal regions.
Putoria calabrica	0-2,000+	X	X		X		5.5 - 8.0	4"	Carpetlike mat with showy flowers.
Thymus squarrosus	0-5,000+	X	X			X	5.5 - 8.0	6"	Very attractive mounting ground cover -- prefers higher elevations.

1/ Preliminary data

Some studies have already been done with propagation of indigenous plants for soil erosion purposes. Since the need for native plants is increasing, more of them will be incorporated in all seed accession plots.

Outplantings of Creeping Sage

After Dr. Eamor Nord's sudden death on February 1, 1976, the Forestry Division outplanted most of the Creeping sage stored at the Riverside Fire Laboratory that was earmarked for fuelbreak plantings in Riverside County. Four sites (Table 5) suitable for Creeping sage were chosen in the Angeles National Forest among conifer plantations and conifer roadside plantings. These sites attempted to take into account most of the conditions preferred by Creeping sage, such as slightly acid and somewhat sandy soils, cooler slopes, moderate to higher elevations, rainfall of at least 15", and occasional summer thunder showers.

All outplantings were done on overcast days. Soil was at or near field capacity except for Site 1 at Spunky Saddle. Here Creeping sage was planted as an understory to a conifer plantation consisting of Aleppo pine (Pinus halepensis) and Arizona cypress (Cupressus arizonica). The limited rainfall before planting had been quickly soaked up by the thirsty vegetation and dry soil and the scarce rainfall after planting was not sufficient to water the plants in properly and penetrate to an appreciable depth.

Spunky Saddle (Site 1) and the roadfill at Big Tujunga Canyon (Site 4) showed the greatest moisture stress within three months after outplanting. Another two months later, both outplantings suffered from extreme moisture stress. Both of these sites had a sandy soil with no topsoil present. The Woodwardia (Site 3) and Clear Creek (Site 4) plantings showed the least moisture stress five months after outplanting. Over the years, soils on both of these sites had built up a thatch of grasses and herbaceous cover which accounted for a layer of topsoil several inches thick.

Nevertheless, due to the sparse rainfall throughout the planting season, plants on all sites showed light to heavy moisture stress by midsummer and expectations for survival were slim. However, with sudden midsummer rains during late August and September (See Appendix for rainfall data), an astonishing revival of plants occurred. Plants already listed as dead weeks earlier came to life again. By the

Table 5 Test plantings of Creeping Sage (*Salvia sonomensis*) in 1976 ^{1/}

Location	Elev.	Avg. Precip.	Slope	Aspect	Soil Text.	pH	Amount Planted	2/ Surv. 6-16	Avg. Size	2/ Surv. 8-13	Avg. Size	3/ Surv. 9-26	Avg. Size
Spunky Saddle Plantation (3-11-76)	3,000'	15" (8") 4/	10° (terraced)	NE	sandy loam	6.8- 7.0	142	90%	6" 30% show moderate, 50% severe moisture stress	50%	4" all show severe moisture stress	68% (96)	4" moderate dieback
Angeles Crest (Woodwardia)	2,700'	27" (15")	0-45° (terraced)	E/S	sandy loam (dec. gran.)	5.0- 5.5	162	100%	18" 5% mod. moist. stress	90%	18" 30% mod. moist. stress	80% (129)	16" mod. dieback
⌈ Angeles Crest (Clear Creek Fuelbreak)	4,500'	31" (19")	45°	N	sandy loam (d.g.)	6.0	244	95%	12" 20% mod. moist. stress	85%	12" 50% mod. moist. stress	88% (215)	12" mod. dieback
Big Tujunga Cyn. Road	5,000'	32" (19")	45°	NW	d.g.	6.5	200	100%	30% mod. moist. stress	85%	6" all show mod. to severe moist. stress	99% (198)	4"
Total: <u>748</u>										Total: <u>638</u> (85%)			

1/ Angeles National Forest. Stock (1-0) outplanted in 8"x2½"x2½" tar liners.

2/ Estimated survival

3/ Actual plant count

4/ (X) rainfall for the 1975-76 season (except for September).
2.33" of rain was received in downtown Los Angeles during September.

end of September 1976, Site 1 with the lowest average rainfall showed the least survival (68%), and Site 4 with the highest elevation and average rainfall showed the highest survival (99.5%). Previous outplantings with bareroot Creeping sage had indicated that the latter site was well suited for this species (Radtke, 1975). Three years after outplanting 20 Creeping sage bareroot seedlings, the ten surviving seedlings averaged 30" in diameter and covered the ground in a near solid strip.

Fuelbreak Projects

East Topanga Fuelbreak

The East Topanga Fuelbreak planting was the first large-scale attempt at establishing fuelbreaks with potted stock of primarily Creeping sage.

After the 1973 Trippet Ranch Fire the area had been seeded to annual ryegrass. The resprouting chaparral and excellent stand of ryegrass found on the cooler exposures were removed by bulldozer in January 1975. Prior to planting, many areas were hand cleared to eliminate the annual ryegrass and mustard. Nevertheless, another bumper crop of ryegrass and mustard quickly inundated the north slopes and mustard and castor bean did the same thing on south slopes. Efforts to introduce grazing failed as the political agreements between private property owners, the State Park System, and Los Angeles County never got off the ground. Use of chemicals was therefore also not possible.

Handcrew labor soon proved prohibitively expensive for weed eradication. Annual ryegrass, mustard, castor bean, and slowly increasing amounts of resprouting chaparral soon formed a competing overstory for the low-fuel plants. The scarce eight inches of rain which fell during the 1975-76 season (excluding September 1976), compared to the average 23 inches which fell the season before, caused heavy dieback and mortality among the low-fuel plants. However, the unexpected summer showers and cool summer months were instrumental in the recovery of many plants on the west and north facing slopes.

The project proved to be an important learning experience in that it showed convincingly that planting or seeding of low-fuel species on a recent burn without the selective use of chemicals or grazing is not feasible because of the prolific germination of fire type annuals and herbaceous

plants. Seeding the burn to ryegrass simply complicates the problem further in supplying competition for planted stock several weeks before the reinvasion of chaparral species.

The weedy species succession cycle which was noticed on the converted areas illustrates the above points. Direct seeding with annual ryegrass after the 1973 Trippet Ranch Fire produced an excellent stand of ryegrass on the cooler exposures by the end of May 1974. After the area was disked in January 1975, a heavy ryegrass stand reestablished itself quickly from the seeds of the previous stand and mustard and castor bean covered most of the south slopes. The excellent seedbed prepared by the bulldozer greatly aided germination. During the unusually dry 1975/76 season, black mustard replaced ryegrass on the dry sites both on warm and cool exposures.

Despite the excellent germination and initial establishment of Creeping sage with the use of pregerminated seeds, all seeding efforts failed on south slopes because of the heavy rodent browsing observed there during July and August 1975. This heavy browsing of Creeping sage seedlings by rodents was quite unexpected and had not been pointed out previously in reviews of this species.

The fungus disease observed on Creeping sage (Radtke, 1975) was heavier on potted stock than seedlings, giving rise to the speculation that the disease was nursery introduced. Fire type annuals like Phacelia grandiflora and also certain shrub species aided the spread of the disease. Healthy plants, often averaging several feet in diameter, would be attacked and would die (perhaps due to the disease) within a matter of months. However, most plants matured and started to form a solid cover. Still, plants seemingly unaffected by the disease would also suddenly die. It is suspected that Creeping sage, through allelopathic agents and heavier soils, is self-limiting in its ability to form a dense, persistent cover.

Creeping sage plants which were released from the competition of matured annual ryegrass stalks (end of growing season) tripled their growth to 18" within three months when compared to non-weeded control plants which averaged 6". This may point to an allelopathic leachate in annual ryegrass stalks or some other allelopathic effect.

Plants in the Creeping sage strain test plot (Table 6) were dying due to drought but some plants recovered during the cool summer of 1976 with its unexpected showers. The mortality to date of all eight strains is 38% and is the result of browsing, drought, and a fungus disease.

Recommendations can not yet be made as to the adaptability of certain strains. However, initial indications are that the southernmost strain, Corte Madera, is the fastest growing and most vigorous. Shingletown, one of the northernmost strains, showed the greatest mortality, poorest vigor and was also highly susceptible to the fungus disease. Another northern strain, Ione, was also highly susceptible to the disease and had the slowest growth rate. It nevertheless showed good vigor.

Table 7B and C also indicate that rodent browsing was greatest in summer and spread of the fungus disease greatest in spring. Studies of the strain tests will continue with the hope that vigorous, disease-resistant strains can be found.

Another important observation made was the relationship of planting methods to erosion. During the 1974-75 planting season, only minimal erosion was noted on slopes above 25° when a "Little Beaver" planting tool was used to drill the holes. However, erosion (washout) was heavy whenever planting holes were dug by hand. Digging holes by hand caused greater soil disturbance and is therefore not recommended for planting on slopes above 25°.

Fire Camp 8 Fuelbreak

Attempts to revegetate an old fuelbreak excessively abused with pre-emergent chemicals and devoid of topsoil was partially successful in that 75% of the planted coyote brush survived on the less harsher sites. These plants measure in excess of two feet and can be readily seen from the nearby fire camp. Plants have experienced setbacks on harsh sites but are very vigorous in areas where runoff water is available.

Additional Projects

Five-hundred-twenty dollars of the Cooperative Research Funds were used for the translation of the pamphlets listed on page 24:

LOW-FUEL PLANT RESEARCH-CREEPING SAGE STRAIN TEST

Dr. Eamor Nord - USFS Riverside

Bob Powers - USFS Redding

Klaus Radtke - LA Co F & FW

Table 6 A Planting Arrangement At The East Topanga Fuel-Break

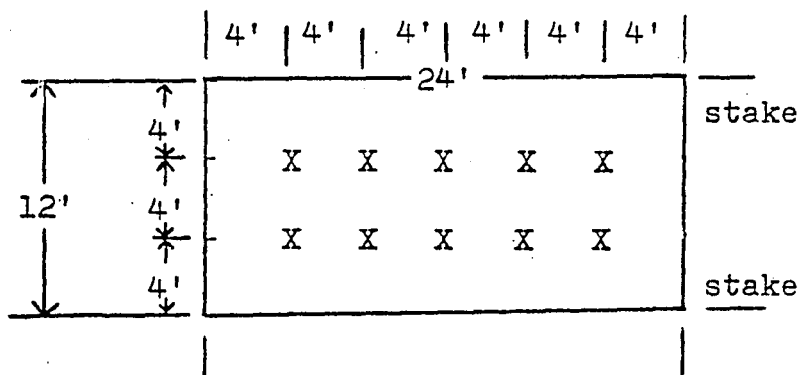
Replicate I	Mariposa 108	Ione	Shingletown	Corte Madera	*12' *12' *12' *12'	24'	48'
	Sugarloaf 163	Inskipp 178	Clear Lake 176	Cuyumaca 190			
Replicate II	Ione	Sugarloaf 163	Shingletown	Clear Lake 176			
	Cuyumaca 190	Mariposa 108	Corte Madera 105	Inskipp 178			
	24'	24'	24'	24'			
← 96' →							

Table 6B Planting Arrangement And Survival Count of May 6, 1975

x x x x x	x x x x x	x x x x x	x x x x x
x x x x x	x x x x x	x x x x o	x D x x x
x D x x x	x x D x x	D x x x x	x D x x D
x x D x x	x x x x x	x x x x x	x x x x x
x x x x x	x x D x x	x x x x x	D x x x x
x x x x x	o o o o o	x x x x D	x x x x x
x x x x x	x x x x x	x x x x x	o o o o o
x x x x x	x x x x x	x x x x x	x x x o o

x - plant alive, D - plant dead, o -none planted

Table 6C Schematic Diagram Of A Subplot



Each subplot has 10 plants at 4' intervals

Table 7 - Test Plantings of Creeping sage

7A Crown diameter measurements 7-29-1975

6 17 9 8 6	2 6 2 10 4	11 6 3 6 7	17 14 4 15 6
14 D 9 9 8	2 2 5 5 2	10 D 7 5 0	6 D 8 3 5
8 D 3 1 8	6 4 D 4 4	D 3 7 1 3	3 D D 7 D
3 6 D 6 7	6 5 6 10 5	8 9 3 6 D	12 4 10 8 15
5 6 8 10 9	1 6 D 5 D	4 13 10 12 9	D 3 6 3 1
2 2 4 14 6	0 0 0 0 0	D 12 9 4 2	9 14 17 3 21
2 6 16 8 10	5 7 2 4 D	10 7 13 12 D	0 0 0 0 0
4 5 5 5 D	5 3 9 5 5	12 3 4 10 9	5 8 5 0 0

7B Crown Diameter measurements 10-10-1975

D 17 10 9 7	7 3 8 7 6	12 8 4 7 7	16 13 5 13 7
12 D 10 10 7	3 3 6 7 3	10 D 8 5 0	6 D 9 2 7
8 D 5 4 9	7 6 D 9 5	D 4 (9) D D	4 D D 7 D
3 4 D 6 8	9 7 7 10 6	11 D 9 D D	12 4 7 (8) (14)
5 D 8 18 10	2 10 D 6 D	5 14 11 15 10	D 3 5 4 1
2 D (5) D 7	0 0 0 0 0	D (12) 7 3 D	5 8 16 D (19)
2 6 15 6 12	5 8 2 5 D	8 10 12 9 D	0 0 0 0 0
5 6 6 5 D	6 4 8 7 6	13 4 5 11 12	D 4 7 0 0

Symbols

- Browsed

(19) Fungus

Damage: 28 plants browsed
6 plants attacked by fungus

7C - Crown diameter measurements 4-28-1976

D 14 15 18 15	18 D 13 18 8	18 19 9 13 15	21 20 18 17 12
15 D (10) 15 6	5 (3) (6) 18 (5)	22 D (14) (3) 0	10 D 12 (2) (15)
11 D (5) (5) 18	13 12 D 28 13	D (4) (7) D D	8 D D 13 D
4 (2) D 8 20	20 11 11 14 (10)	26 D (15) D D	20 D 12 13 22
(7) D (5) 19 15	15 13 D 20 D	(8) (6) 9 20 (16)	D D 12 D D
3 D D D 10	0 0 0 0 0	D D D D D	D D D D 20
2 8 7 D 15	11 9 (1) 11 D	D 22 15 12 D	0 0 0 0 0
(3) 3 8 7 D	7 5 12 7 11	18 15 (11) 14 20	D D D 0 0

Damage: 3 plants browsed
22 " attacked by fungus

Table 7 D - Test Plantings of Creeping sage

Crown diameter measurements and vigor ratings 9-27-1976

D 11 _F 14 _F 18 _F 16 _F 18 _E D 9 _G 15 _G 3 _F 22 _F 16 _F 6 _F 8 _F 17 _G 22 _G 17 _G 21 _G 20 _G 11 _F	<u>Vigor Ratings</u>
15 _F D 9 _F 16 _F 4 _F 4 _G 2 _F 4 _F 18 _G 5 _P D D 13 _P D 0 8 _G D 15 _G D 16 _F	E=4=vigorous no die-back
10 _G D 4 _F 5 _F 9 _P 14 _G 8 _F D D 18 _P D 2 _F 8 _F D D 7 _F D D 17 _F D	G=3=vigorous light to moderate dieback
4 _G 2 _P D 8 _G 21 _G 22 _F 8 _F 8 _P 14 _G D 23 _G D 16 _G D D 18 _F D 11 _F 9 _F 23 _G	
7 _G D 4 _F 14 _F 14 _F 13 _F 17 _G D 22 _G D D D D 17 _F 6 _P D D D D D	
4 _F D D D 12 _G 0 0 0 0 0 D D D D D D D D D 18 _F	F=2=vigorous moderate to heavy dieback
2 _F 2 _P D D 15 _E 8 _G 11 _G D 10 _G D 30 _G 11 _F 12 _G D D 0 0 0 0 0	
2 _P 2 _P 6 _F 8 _G D 9 _E 7 _G 13 _E 5 _F 10 _G 17 _G 15 _G 12 _G 15 _G 15 _G D D D 0 0	P=1=poor vigor heavy dieback
Damage: 4 plants browsed 0 " attacked by fungus disease	

Damage: 4 plants browsed
0 " attacked by fungus disease

1. The Combustible Vegetation in the County of L'Herault, France.
2. Research Progress Report 1972-73 of the Research Institute of Forest and Rangelands, Iran.
3. Land Management in the O.V.S. Province, South Africa.

Copies of the first two translations are attached to this report. Work on the third translation is still in progress.

Other projects include the chemical analysis of plant tissues of selected introduced plant species for both fire-retardant and poisonous properties and also for suitability as forage (Table 8).

All plants listed, with the exception of Atriplex repanda, were from 6 to 18 months old. Succulent tip cuttings of all plants were analyzed as a combined sample of leaves and stems except for Atriplex repanda, where only semi-hardwood tip cuttings of 2 to 3 year old plants were available, and for Polygonum equisetiforme, where the whole plant was analyzed. Furthermore, plants at the Wayside Honor Ranch plot in Castaic were about one year younger than plants at the Malibu plot and had been continuously irrigated for seed production. The moisture content (as compared to the dry weight) of the saltbush species at Castaic was therefore over 100% higher than the moisture content of saltbush species at Malibu. The high summer moisture content of over 300% for all species analyzed, except for Polygonum equisetiforme, is attributed to the unusually wet summer of 1976 and irrigation for seed production.

Crude protein content for all species was above 12.5% with the exception of Polygonum equisetiforme which had a low value of 5.7%. Compared to a May 1976, analysis of crude protein (see Table 9, Appendix), the crude protein content of most plants increased significantly during the unusually wet summer of 1976. The highest difference was found with Lycium spp., whose succulent tip cuttings which were greenhouse grown averaged 8.4% in May 1976, and those that were field grown averaged 33.0% in September of the same year. The exception was again Polygonum equisetiforme, whose value decreased from 13.2% to 5.7%.

Total ash content of all saltbush species was above 17.0% and was much higher than all other plants tested. This high ash content again emphasizes the usefulness of the saltbush genera in reducing fire spread.

Plant tissue tests of the above and other plants under study will continue this winter with more emphasis placed on native plants.

Close cooperation with regional Plant Materials Centers and the introduction of seeds through the Agricultural Research Center (Dr. H. Highland) in Beltsville, Maryland, made the Forestry Division more aware of both weedy and poisonous properties of introduced plants. Correspondence carried on by both the Fire Laboratory and the Forestry Division with many other agencies then revealed that green galenia (Galenia pubescens) and capeweed (Arctotheca calendula), two low-fuel plant species not introduced by the Forestry Division, are potentially poisonous.

Green galenia was initially believed to be poisonous because of its oxalic acid content of 3.7% to 7.1% which may have been responsible for the "Waterpens" disease reported in sheep from South Africa. However, the latest reports from the Poison Plant Center in Logan, Utah, indicate that this plant is poisonous because of its potassium nitrate content of about 2.5%. Capeweed is thought to be poisonous because of alkaloids which cause gastritis and which taint milk products.

Table 8 Chemical composition of selected low-fuel plant introductions ^{1/}

No.	Name	Source	2/											
			Moisture Content %	Protein Crude %	Fat Crude %	Fiber Crude %	N-Free Extr. %	Ash Tot %	Ca %	Mg %	Na %	K %	P %	NO ₃ -N %
1.	Atriplex coquimbana	Malibu-N	373	20.6	2.6	12.7	39.7	17.1	1.6	1.0	2.2	4.8	0.3	0.27
2.	Atriplex glauca	Castaic-W	530	26.7	2.4	8.1	36.0	18.7	1.0	0.8	4.3	3.9	0.4	0.13
3.	Atriplex malvana	"	468	21.0	2.7	8.4	38.1	21.5	1.2	0.9	4.9	3.5	0.4	0.02
4.	Atriplex repanda	Malibu-N	342	15.5	2.7	13.5	40.4	20.7	1.0	1.1	5.8	0.8	0.2	0.12
5.	Atriplex undulata	Castaic-W	416	25.6	2.7	8.9	34.3	21.3	1.0	0.7	5.2	4.0	0.4	0.18
6.	Hardenburgia violacea	Malibu-N	326	19.9	2.7	14.0	49.4	6.4	0.6	0.8	0.1	3.1	0.3	0.32
7.	Hertia cheirifolia	Malibu-N	693	16.0	7.4	13.6	42.0	12.7	1.5	1.0	0.2	3.9	0.2	0.30
8.	Lycium spp.	"	553	33.0	4.7	9.9	33.2	10.1	0.9	0.8	0.1	3.9	0.4	0.01
9.	Polygonum equisitiforme	"	144	5.7	1.5	24.1	57.9	4.0	0.6	0.8	0.2	1.6	0.1	0.33
10.	"Rapeise"	"	360	12.5	12.6	14.5	43.5	8.9	1.1	0.9	0.1	3.4	0.3	0.22

1/ Agri Science Laboratories, Los Angeles. Current growth of small twigs and leaves of all plants was analyzed as a composite sample. Samples were taken 9-25-76 during an unusually wet summer.

2/ The moisture content was calculated as the total moisture content of the plant when compared to its dry weight. Other columns give figures as percentage of dry weight.

LOW-FUEL PLANT PROJECT REPORT #5
(July 1, 1976 - September 30, 1976)

Project Roundup

During the final phase of the Cooperative Agreement, the Los Angeles County Forestry Division found itself tackling many projects. Four test plots (three at the Research Center in Malibu and one at the Wayside Honor Rancho, Castaic) needed to be maintained for plant evaluation of recently introduced species and for seed accession; plants in numerous dry site test plots established under wildland conditions had to be evaluated. The phasing out of the Riverside Low-Fuel Plant Project after the death of Dr. Nord also required our attention.

It was hoped that Dr. Nord's notes could soon be evaluated for some final papers that perhaps could be published, but this project will have to wait. However, since the Forestry Division will be continuing low-fuel plant research as one tool for chaparral management, it is hoped that the many unfinished projects will eventually be completed. The project on pregermination of shrub seeds for direct seeding in arid regions was supposed to be carried out this last spring but was interrupted by lack of rain and Dr. Nord's death. The project will hopefully be continued this winter and can perhaps show that laboratory pregerminated seeds are one answer to guaranteeing a better field establishment of shrubs under wildland conditions in dry regions of the world.

SUMMARY

The Low-Fuel Plant Program has proved no exception to all other revegetation attempts in arid regions. Such attempts are often costly and only met with limited success because of the climate extremes, limited and undependable rainfall and the complications man's management (or mismanagement) has caused in the region.

Through diligent field work consisting of growing, out-planting, observing, and recording plant adaptations, an excellent list of plants for greenbelt plantings around homes and for fuel hazard reduction along roadsides has been established. Many of these plants are already proving their value to commercial growers and landscapers.

The list of plants for wildland plantings to reduce the fire hazard is much smaller. However, if additional management practices such as grazing fuelbreaks are more readily adopted and other values such as erosion control, aesthetics, mine spoil reclamation, etc. are considered, the list of plants also becomes quite impressive.

Fuelbreak type mass plantings of low-fuel plants have neither proven themselves to be economically feasible nor practical. Most arid region plants studied have a colonial and not single species communal growth habit and are therefore more readily adapted to the micro-conditions found scattered throughout the wildlands. Their long term survival is also governed by the occasional extreme drought year which occurs periodically.

Extensive planting efforts with Creeping sage, often recommended as California's number one low-fuel plant, have in general been quite disappointing. In Southern California the plant prefers higher elevations, sandy-loam soils with pH below 6.5 (slightly acid), cooler exposures with an open overstory, and precipitation in excess of 20". Occasional summer thundershowers aid its survival. It is therefore best adapted to those limited sites and isolated native habitats where its manipulation can be of great benefit. Such is the case in Lake County, California, where C.D.F. Conservation Crews under the direction of local foresters have encouraged the spread of Creeping sage through selective clearing of the overstory. The plant then forms an effective fuelbreak along roadsides.

Table 9

CRUDE PROTEIN ANALYSIS OF SELECTED LOW-FUEL PLANTS 1/
(KJEDAHN TECHNIQUE)

<u>Name & Sample Number</u>	<u>Plant Part</u>	<u>%Crude Protein</u>
Acacia ongerup #1	leaves	10.00
Acacia ongerup #1	stems	12.5
Acacia ongerup #2	leaves	12.0
Acacia ongerup #2	stems	10.8
Arthopodium canandium	entire plant 3/	20.15
Atriplex coquimbana	leaves	8.5
Atriplex coquimbana	stems	18.25
Atriplex glauca	leaves	16.2
Atriplex glauca	stems	10.6
Atriplex malvana	leaves	17.0
Atriplex malvana	stems	12.9
Atriplex repanda	leaves	19.75
Cistus crispus #1 (Descanso)	leaves	13.3
Cistus crispus #1 (Descanso)	stems	7.54
Cistus crispus #2 (Descanso)	leaves	16.5
Cistus crispus #2 (Descanso)	stems	8.6
Hertia cheirifolia #1	leaves	15.8
Hertia cheirifolia #1	stems	16.7
Hertia cheirifolia #2	leaves	12.40
Hertia cheirifolia #2	stems	14.7
Lycium spp.	leaves	8.5
Lycium spp.	stems	8.2
Polygonum equisetiforme	entire plant 3/	13.15
"Rapeise"	leaves	7.23
"Rapeise"	stems	5.95

-
- 1/ As analysed in May 1976, by Ron Carasco and Richard Ray, Humboldt State University Range Management Students. Samples were furnished by the Los Angeles County Forestry Division.
 - 2/ Each plant was separated into leaves and stems, and each plant part was analysed twice. Crude protein percentages represent an average of these two runs.
 3. Entire plant was analysed when insufficient amounts of material was present for separate analysis.

LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT
HYDRAULIC DIVISION

Station No. 122G

Foreign Station No.

Quad-Index No.

SEASONAL RAINFALL AT Leona Valley - Rackett Ranch SEASON 1975-76

Record Furnished by..... Copied by..... Date Copied.....

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1						.68						
2												
3						.57						
4							.10					
5					.34			.03				
6	T				1.46			.23				
7					.59							
8					.59		.27					
9					.89							
10						.10						
11	.48						.02					
12			.24									
13							1.00					
14												
15												
16							.08					
17												
18												
19												
20												
21												
22										T		
23												
24												
25												
26												
27												
28												
29		.25										
30	.26											
31												
TOTAL	.74	.25	.24	0	3.87	1.35	1.47	.26	0	T	0	

7.92

SEASON TOTAL

REMARKS:

LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT
HYDRAULIC DIVISION

Station No. 726

Foreign Station No.

Quad-Index No.

SEASONAL RAINFALL AT ANGELES CREST GUARD STATION SEASON 1975-76

Record Furnished by..... Copied by..... Date Copied.....

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1						1.98						
2						.96						
3						.81						
4					.04		.37					
5					.63		.13					
6					2.27			.03				
7	.22				.39			.25				
8					.85		.15					
9					1.26							
10					.93	.22			.20			
11	.40						.05					
12			.12									
13			.58				1.00					
14							.15					
15							.15				.28	
16											.47	
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27		.05										
28		T										
29		.01										
30	.15											
31												
TOTAL	.77	.06	.70	0	6.37	3.97	2.00	.28	.20	0	.75	

.....SEASON TOTAL.....

REMARKS:.....

CLEAR CREEK FUELBREAK SITE

76S345-57- Cdb 12-71

LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT
HYDRAULIC DIVISION

Station No. 1152

Foreign Station No.

Quad-Index No.

SEASONAL RAINFALL AT Clear Creek Ranger Station SEASON 1975-76

Record Furnished by..... Copied by..... Date Copied.....

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1						1.95						
2						.67						
3						1.27						
4					.04		.49					
5					.93		.14					
6					2.73			.03				
7	.15				.45			.27				
8					.61							
9					3.09		.22					
10			T		1.63	.17			.14			
11	.45					.02	.06		.07			
12	.01		.05									
13			.55				1.52					
14							.20					
15							.18				.21	
16											.16	
17												
18												
19					.01							
20												
21												
22												
23										.04		
24					.10							
25												
26												
27		.05										
28		T										
29		.01										
30	.13											
31												
TOTAL	.74	.06	.60	0	9.59	4.08	2.81	.30	.21	.04	.37	

SEASON TOTAL.....

REMARKS:.....

LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT
HYDRAULIC DIVISION

Station No. 1159
Foreign Station No.
Quad-Index No.

SEASONAL RAINFALL AT Shortcut Canyon - West Fork SEASON 1975-76
Record Furnished by..... Copied by..... Date Copied.....

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1												
2												
3						1.1	.					
4					.2		.3					
5					.8							
6					2.6							
7					1.9		.1	.20				
8					3.6		.1					
9					4.6							
10					1.0				.1			
11	4											
12			.2			.1			.1			
13							1.0					
14												
15							.2				.2	
16							.1					
17												
18												
19												
20												
21			.1									
22							.1					
23												
24												
25												
26												
27												
28						.1						
29												
30												
31												
TOTAL	4	0	.3	0	14.7	1.3	1.9	.2	.2	0	.2	

SEASON TOTAL
REMARKS:

VICINITY OF EAST TOPANGA FUELBREAK

76S345-57- Cdb 12-71

LOS ANGELES COUNTY

FLOOD CONTROL DISTRICT

HYDRAULIC DIVISION

Station No. 6.....

Foreign Station No. ..BQ.....

Quad-Index No.

SEASONAL RAINFALL AT.....Topanga Canyon Patrol Station.....SEASON.....1975-76.....

Record Furnished by.....Copied by.....Date Copied.....

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1						1.0						
2												
3						.6						
4					.2		.4					
5					.2							
6					1.1							
7					.5							
8					.6		.1					
9					1.9							
10					4	.1			.10			
11	.4						.1					
12												
13			.1				.3					
14							.1					
15												
16												
17												
18												
19												
20												
21												
22										.10		
23												
24												
25												
26												
27												
28												
29												
30												
31												
TOTAL	.4	0	.1	0	4.9	1.7	1.0	0	.10	.10	0	

SEASON TOTAL

REMARKS:

INDEX OF PLANTS MENTIONED

Latin Name

Acacia ongerup	7, 10, 12, 30
Arctotheca calendula	25, 30
Artemisia caucasica	8, 10, 15
'Arthropodium canandium'	30
Atriplex coquimbana	10, 11, 12, 26, 30
Atriplex glauca	10, 11, 12, 26, 30
Atriplex hymenelytra	11
Atriplex malvana	11, 12, 26, 30
Atriplex muelleri	8, 11
Atriplex nummularia	4
Atriplex repanda	10, 11, 12, 24, 26, 30
Atriplex rhagioides	8, 10, 11, 12
Atriplex undulata	10, 11, 12, 26
Baccharis pilularis	8, 20
Brassica spp.	4, 18, 19
Cistus crispus ('descanso')	8, 30
Cistus ladaniferus	8
Cistus villosus	8
Cupressus arizonica	16
Eriogonum wrightii spp. subcaposum	13
Galenia pubescens	8, 11, 25, 26
Hardenburgia violacea	15, 26
Hertia cheirifolia	15, 26, 30
Kennedia rubicunda	13
Lolium spp.	5, 18, 19
Lycium spp.	10, 14, 26, 30
Myoporum parvifolium	8
Oenothera drummondii	10, 14
Phacelia grandiflora	19
Pinus halepensis	16
Polygonum equisetiforme	10, 13, 24, 26, 30
Putoria calabrica	15
"Rapeise" 1/	25, 30
Ricinis communis	5, 18, 19
Rosmarinus officinalis	4, 8
Salvia sonomensis	1, 8, 16, 17, 18, 19, 20, 27
Santolina chamaecypariss	8
Santolina virens	8
Thymus squarrosus	15

1/ Native Lesotho (S. Africa) name.

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